**USDA-ARS/**
**U.S. Wheat and Barley Scab Initiative**
**FY09 Final Performance Report**
**July 15, 2010**

# Cover Page

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| **Fiscal Year:** | 2009 |
| **USDA-ARS Agreement ID:** | 59-0206-9-086 |
| **USDA-ARS Agreement Title:** | Discovering, Understanding, and Utilizing Wheat Genes for FHB Resistance in Ohio. |
| **FY09- USDA-ARS Award Amount:** | $ 100,428 |

**USWBSI Individual Project(s)**

| USWBSI Research Category* | Project Title | ARS Adjusted Award Amount |
|---|---|---|
| VDHR-NWW | Uniform Nursery for SRWW and Development Scab Resistance Varieties for Ohio. | $ 81,951 |
| VDHR-NWW | Mapping QTL for Type I and II FHB Resistance from CIMMYT Germplasm derived from a Synthetic Hexaploid. | $ 2,927 |
| VDHR-NWW | Mapping Fusarium Head Blight Resistance in Truman Wheat. | $ 2,305 |
| VDHR-NWW | Mapping FHB QTL in an IL97-1828 x Clark Derived RIL Population. | $ 2,927 |
| PBG | The Molecular Basis for the Low DON Accumulation Phenotype in Winter Wheat. | $ 10,318 |
| | **Total Award Amount** | **$ 100,428** |

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Principal Investigator Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Winter Wheat Region
SWW – Southern Sinter Wheat Region

**Project 1:** *Uniform Nursery for SRWW and Development Scab Resistance Varieties for Ohio.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Host resistance is viewed as the foundation of FHB control. We are attempting to improve FHB resistance in high-yielding cultivars adapted to the upper Midwest. Traditional plant breeding and MAS are being used. We screened 1120 OSU breeding lines and 220 lines from uniform tests and the state variety trials for FHB resistance in FHB Nursery. We spray inoculated an additional 7500 RILs at the F4:5 head row stage and selected families with low symptoms. In addition we initiated or continued MAS backcrossing of FHB1 and sometimes for FHB QTL on 5A, 2D, and 3B in about 15 genetic backgrounds.

   We coordinated the 2008-2009 Uniform scab nurseries for the northern soft wheat region which contained 120 entries. Results were compiled and distributed to all interested parties.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   **Accomplishment:** Of the 1120 OSU breeding lines screened in 2008-2009, 34% had a FHB index less than that of Truman [R], 53% had an FHB index less than that of Freedom (MR). Only 4% had an FHB index greater than the susceptible check. Our latest releases, Bromfield (Index = 6.7%) and Malabar (Index = 4%) had low FHB similar to Truman (Index = 4.8%). In the 2009-2010 state trial of commercial cultivars, Malabar was 9$^{th}$ (of 55 entries) for yield, 2$^{nd}$ best for FHB index, and 6$^{th}$ best for test weight.

   **Impact:** The high frequency of lines with acceptable FHB resistance (eg equal to or better than Freedom) facilitates finding high-yielding cultivars with FHB resistance. Seed of Malabar is now widely available. It has better yield, TW, and FHB resistance than many varieties that are widely grown in Ohio. The immediate adoption of Malabar by growers would reduce DON levels in Ohio produced wheat.

**Project 2:** *Mapping QTL for Type I and II FHB Resistance from CIMMYT Germplasm derived from a Synthetic Hexaploid.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Breeding for host resistance for FHB is difficult and laborious when relying solely on phenotypes. Identifying an array of effective QTL that can be used in MAS and that complement FHB1 (on 3BS) would be very beneficial. To that end we phenotyped RILs from a cross of a CIMMYT spring wheat line x a susceptible adapted soft winter wheat. We also genotyped the population with markers from genomic regions that have been associated with FHB resistance in the literature to see if the CIMMYT lines had novel QTL.

   The population was very skewed for many markers making it a very poor candidate for extensive mapping. In 2008-09 we added more phenotypic data to this population and some more markers to wrap up the story for the key regions of the genome.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   **Accomplishment:** Our final QTL analysis confirmed that 3BS and 5AS were not important for FHB resistance in this population. Of know QTL, only the QTL on 2D was important and it accounted for 25% of the phenotypic variation. We identified 17 RILs with better resistance than Truman and selected among those for best agronomic value. Aside from 2D, the CIMMYT parent appears to contribute FHB resistance genes that are not associated with FHB1, 5A, or 3B and thus is novel from those published QTL. While we have not mapped those QTL, the most resistant RILs with the 2D markers will make good parents for incorporating FHB resistance

   **Impact:** The RIL we have identified derived from the CIMMYT parent likely have novel FHB resistance genes along with the 2D QTL for FHB resistance. The lines have been purified and selected for adaptation to the Midwest and their agronomic value.

**Project 3:** *Mapping Fusarium Head Blight Resistance in Truman Wheat.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Breeding for host resistance for FHB is difficult and laborious when relying solely on phenotypes. Soft red winter wheat (SRWW) harbors considerable FHB resistance yet the underlying genetics of this valuable resource is poor understood. Truman is one of the most resistant SRWW. This study will identify QTL for FHB resistance from Truman. OSU is participating in this University of Missouri lead project. We phenotyped all RILs and parents of this population in 2008 and in 2009.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   **Accomplishment:** We phenotyped 235 RILs from the Truman/MO94-317 population in 2008-2009 collecting incidence, severity, index and DON data. Truman had an index of 3.8% while MO94-317 had an index of 40.6%: the index of the RILs ranged from 0.5-96.8%. Data was provided to University of Missouri

   **Impact:** Collectively, the data on the RILs will be used to identify the QTL for FHB resistance from Truman. Truman is an adapted SRWW that has been used extensively as a parent in most SRWW breeding programs. This identification of its QTL will lead to immediate MAS as it genes are already present in most breeders populations.

**Project 4:** *Mapping FHB QTL in an IL97-1828 x Clark Derived RIL Population.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Breeding for host resistance for FHB is difficult and laborious when relying solely on phenotypes. Soft red winter wheat (SRWW) harbors considerable FHB resistance yet the underlying genetics of this valuable resource is poor understood. IL97-1828 is one of the most resistant SRWW. This study will identify QTL for FHB resistance from IL97-1828. OSU is participating in this University of Illinois lead project. We phenotyped all RILs and parents of this population in the 2009-2010 season.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   **Accomplishment:** FHB pressure in the 2009-2010 nursery was excellent and there was considerable segregation for FHB resistance in this population. Data was collected in mid June of 2010 and is being analyzed.

   **Impact:** The data will be combined with data from Illinois for a QTL analysis. If identified, QTL from IL97-1828 are likely present in many SRWW breeding programs and therefore MAS can be immediately implemented.

**Project 5:** *The Molecular Basis for the Low DON Accumulation Phenotype in Winter Wheat.*

**1. What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

Most breeding for FHB resistance focuses on reducing spike symptoms (eg TI and TII resistance) which indirectly also reduce DON in grains. There are lines that have good TI and/or TII resistance but still produce grain with high DON, and vice versa. We have found variation for resistance to kernel infection (RKI, eg less kernel infection than expected based on FHB index) and resistance to toxin accumulation (RTA, eg less DON in kernels than expected based on level of kernel infection). While we have documents some variation for RKI and RTA in SRWW, phenotyping either is laborious and expensive so we have sought more rapid screens for these traits.

Lines with high and low RTA were grown in 2008-2009 and grain harvested from heads with different levels of FHB index. Each sample from each infection level from each genotype was analyzed separately. The samples were assayed for Fg (using QPCR), DON, and levels of other compounds (Phenolics, Poly Phenyl Oxidase (PPO), Super Oxide Dimutase (SOD), Catalase (CAT), and phytate) that may be related to RTA.

In a separate experiment, the lines with and without RTA were grown in the GH, spray inoculated and spikes collected at different times. RNA was isolated and is being analyzed for Fg gene expression by Linda Harris (Eastern Cereal & Oilseed Research Centre, Agriculture and Agri-Food Canada).

**2. List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

**Accomplishment:** We were able to repeat the RTA ranking of the lines and DON remained very low in several of the RTA lines despite very high infection levels. The lines with and without RTA did not differ in Fg infection, though the RTA+ lines had 3.7 ppm DON versus 8.6 ppm DON for the RTA- lines. The RTA+ lines had significantly less phenolics and PPO than the RTA- lines. The RTA+ lines significantly more SOD and CAT than did the RTA- lines.

**Impact:** We have shown that there is repeatable variation for RTA. We postulate that a combination of TI, TII and RTA is needed to reliably produce grain with low DON. It is possible the rapid biochemical assays, and or Fg expression assays, may be useful in selecting for RTA,

**Include below a list all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance.**

**Release of wheat germplasm line OH02-12686**

| | USWBSI averaged three years | | | | | | | OSU 2007-2009 | OSU 2003-2009 |
|---|---|---|---|---|---|---|---|---|---|
| NAME | INC % | SEV % | IND % | FDK % | ISK % | DON ppm | GH SEV % | IND % | IND % |
| TRUMAN [R] | 31.8 | 18.9 | 9.7 | 13.7 | 23.4 | 4.2 | 3.4 | 4.0 | |
| FREEDOM (MR) | 54.3 | 28.5 | 16.5 | 26.7 | 39.7 | 6.4 | 14.5 | 8.6 | 16.0 |
| OH02-12686 | 46.3 | 29.8 | 16.9 | 24.3 | 35.9 | 3.5 | 14.2 | 3.9 | 11.1 |

**Release of wheat cultivar Bromfield**

**Release of wheat cultivar Malabar**

| | Index (%) | | | DON (ppm) | | |
|---|---|---|---|---|---|---|
| | 2007 NUWWSN | 2006 NUWWSN | 2006, 2007 OSU | 2007 NUWWSN | 2006 NUWWSN | Average |
| Truman [R] | 6.1 | 12.4 | 0.3 | 3.9 | 4.5 | 4.2 |
| Freedom (MR) | 15.2 | 16.4 | 1.5 | 5.8 | 7.0 | 6.4 |
| Bromfield | 17.0 | 16.2 | 2.6 | 4.2 | 3.8 | 4.0 |
| Malabar | | 10.2 | 0.3 | | 7.0 | |

**Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.**

Li, C. P Paul, M Guttieri, L Madden, C Sneller, C. 2009. A Pcr-based approach to characterizing resistance responses of soft red winter wheat cultivars to Fusarium graminearum infection. Phytopathology. Vol. 99, no. 6, Suppl. S: S72-S73.

Odenbach, K, M Guttieri, C Sneller, L Madden, L, and P Paul. 2009. Association between post-anthesis infection and deoxynivalenol accumulation in grain from spikes without visual symptoms of Fusarium head blight. Phytopathology. Vol. 99, no. 6, Suppl. S: S96.

Sneller, C, P Paul, and M Guttieri. 2010. Characterization of resistance to Fusarium Head Blight in an Eastern US soft red winter wheat population. *Crop Science* 50:123-133.